

# Verifying the Performance of a Coupled Fire-Atmosphere Model



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# Colorado Fire Prediction System (CO-FPS)



Rep Tracy  
Kraft-Tharp

Dr. Jim Hurrell  
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Hickenlooper

Dr. Janice Coen  
NCAR/MMM

Signed May 20, 2015



HOUSE BILL 15-1129

BY REPRESENTATIVE(S) Kraft-Tharp, Duran, Garnett, Ginal, Hamner, Kagan, Mitsch Bush, Pettersen, Rosenthal, Ryden, Salazar, Singer, Vigil, Williams, Winter, Hullinghorst, Lontine, Pabon;  
also SENATOR(S) Roberts, Grantham, Heath, Aguilar, Carroll, Donovan, Hodge, Jones, Kefalas, Kerr, Merrifield, Newell, Todd.

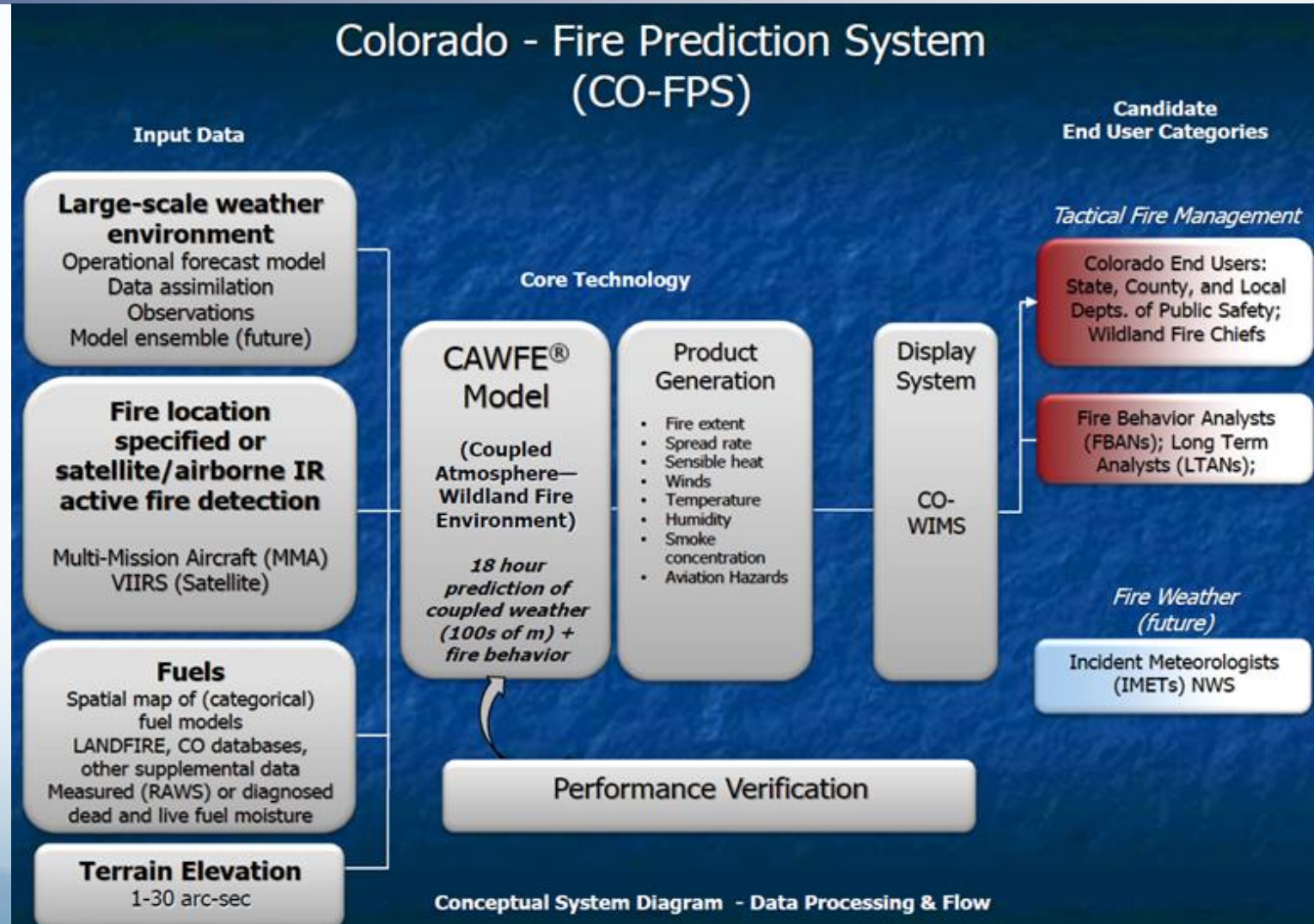
CONCERNING DISASTER PREDICTION AND DECISION SUPPORT SYSTEMS BY THE DEPARTMENT OF PUBLIC SAFETY, AND, IN CONNECTION THEREWITH, MAKING AN APPROPRIATION.

*Be it enacted by the General Assembly of the State of Colorado:*

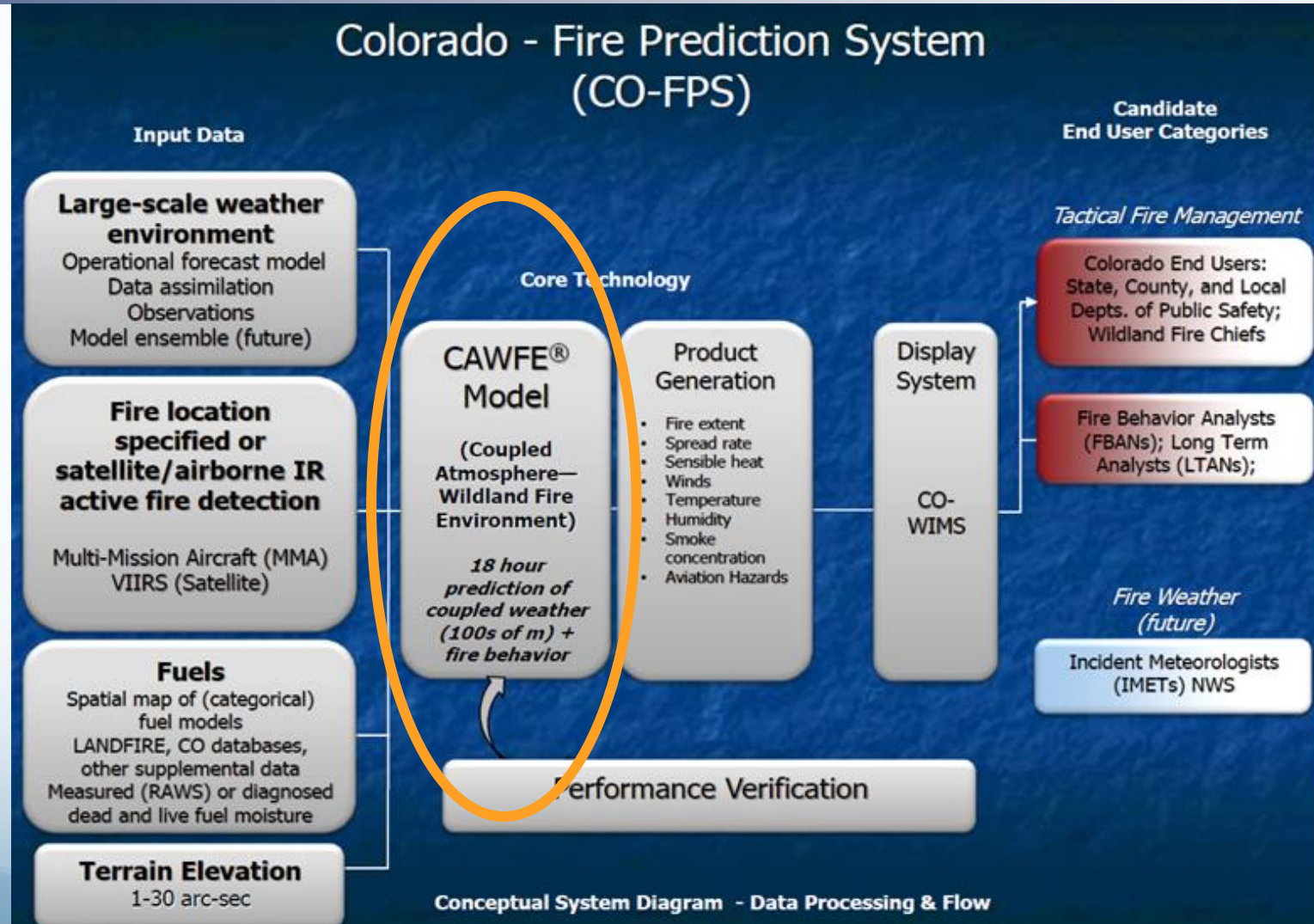
**SECTION 1. Legislative declaration.** (1) The general assembly hereby finds and declares that:

(a) Wildland fires are exceedingly complex phenomena. Despite rigorous training, abundant resources, and weather forecasts, even seasoned responders may be tragically unprepared for complex, unpredictable, and dramatic fire behavior. Human intelligence cannot integrate all the interacting factors to anticipate when weather and other factors will combine with topography to dramatically amplify fire behavior.

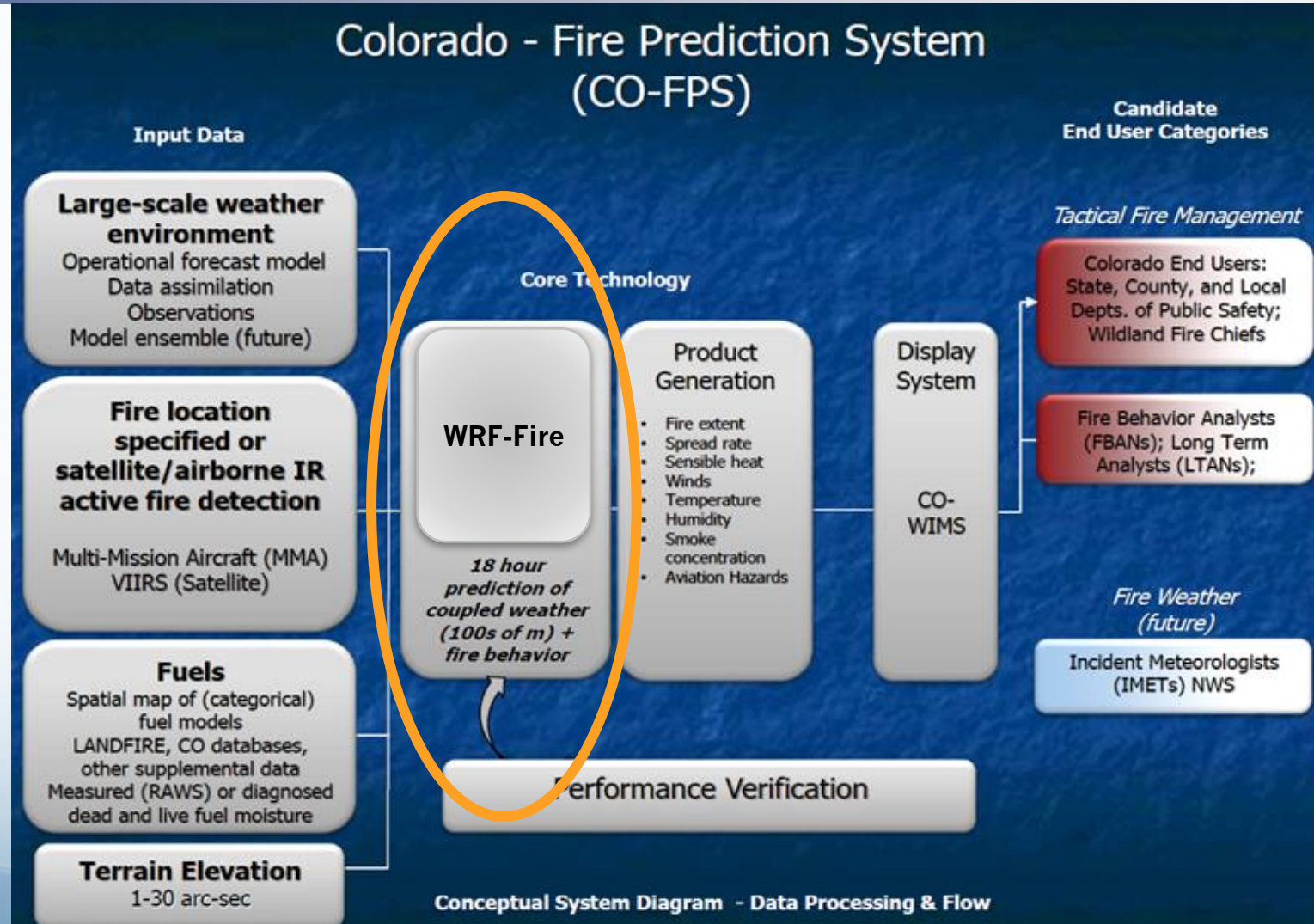
# CO-FPS Framework



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# WRF-Fire: A Coupled Model

The wind (i.e. atmosphere) affects the rate of spread and direction of fire as well as fuel moisture (which determines weather and how intensely a fire burns).



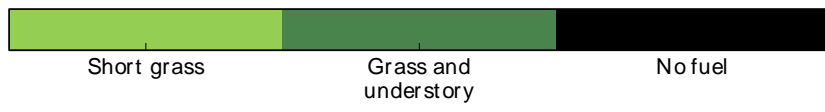
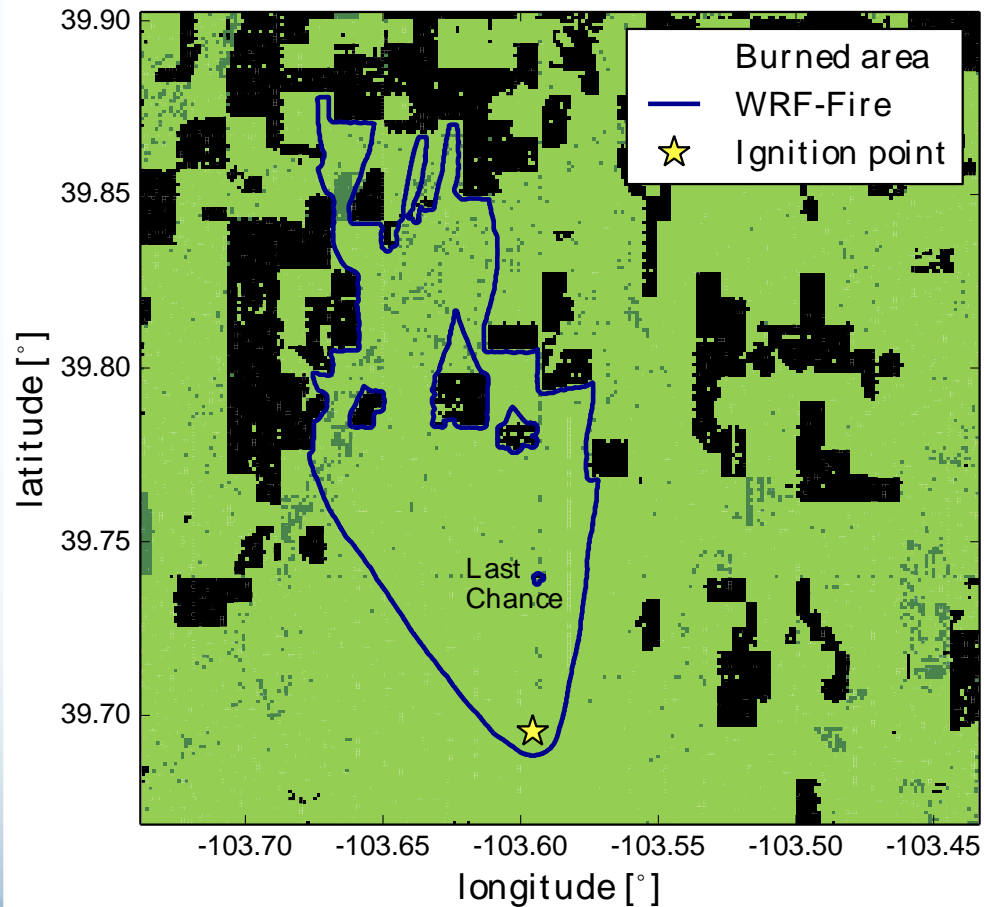
Sensible and latent heat  
and smoke

Wind speed and direction,  
and humidity

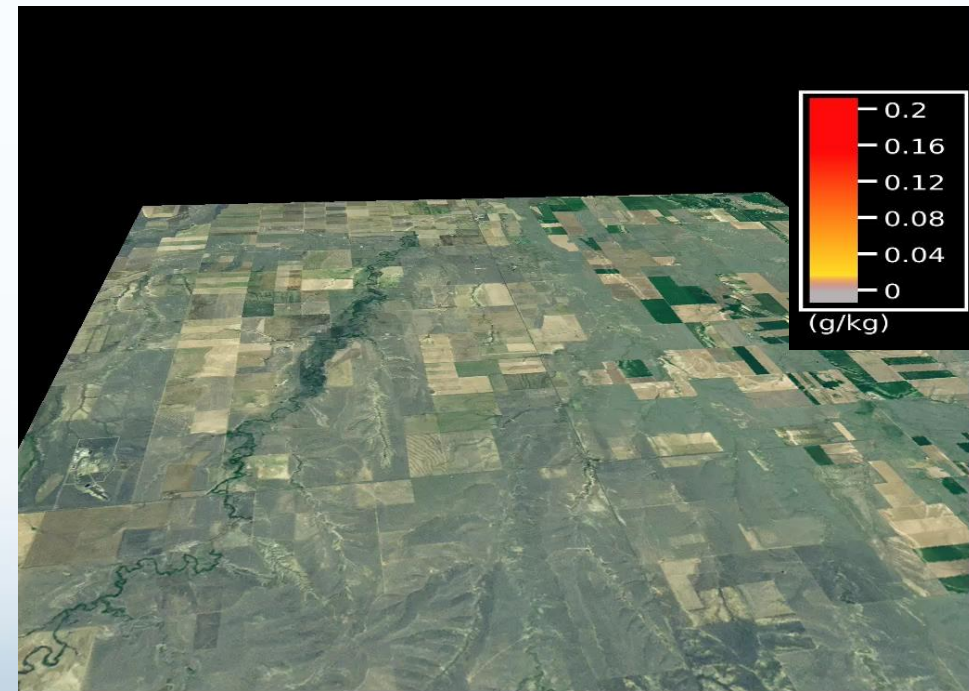
Burning fuel releases heat and water vapor into the atmosphere, causing updrafts and changing the winds



# Example Case: Last Change (2012)



Smoke concentration:  
0700 – 1900 LT  
June 25<sup>th</sup> 2012



*Courtesy Pedro Jimenez*

# Challenge for Verification

## Weather is...

Modeled worldwide, often on a regular grid

Always occurring

Observed regularly and to standards

Regular repositories of data are available

## Wildfire is...

Modeled only at the location of the fire

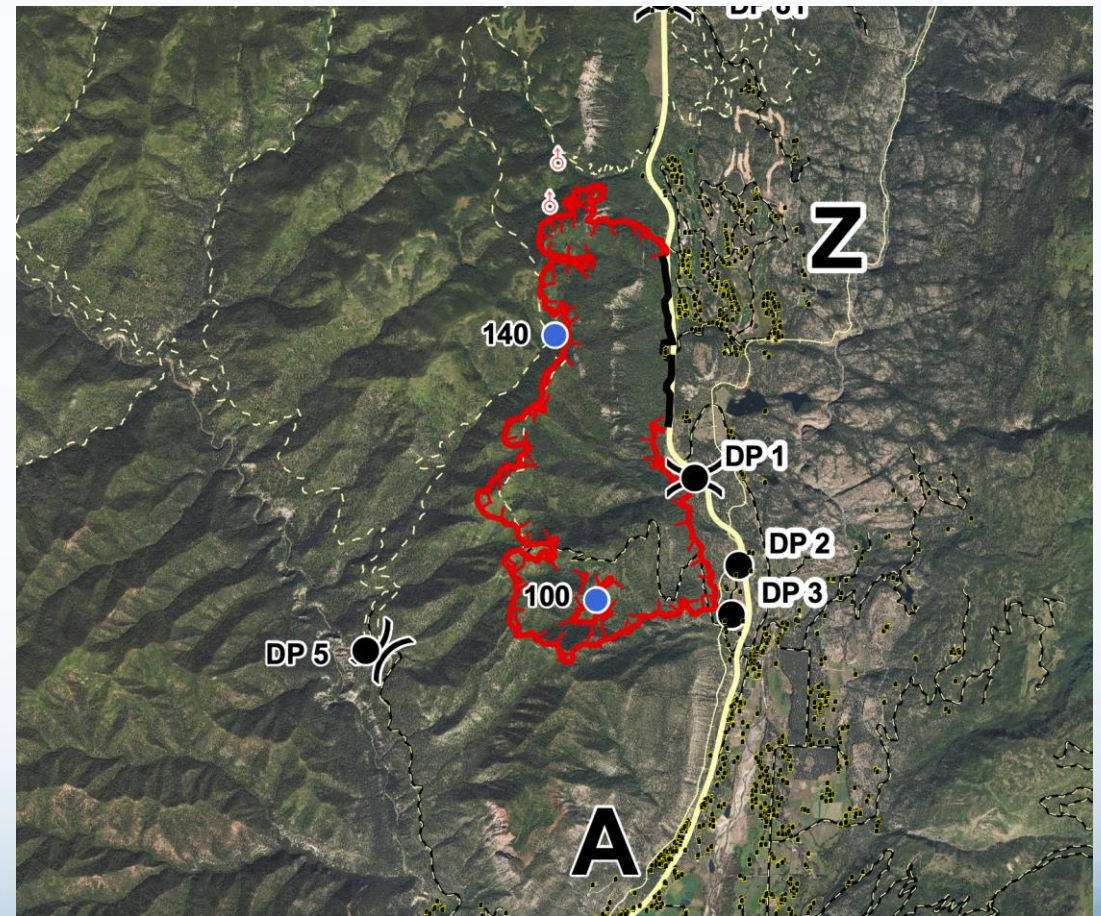
Occurs with little forewarning

Observed to provide tactical, real time data

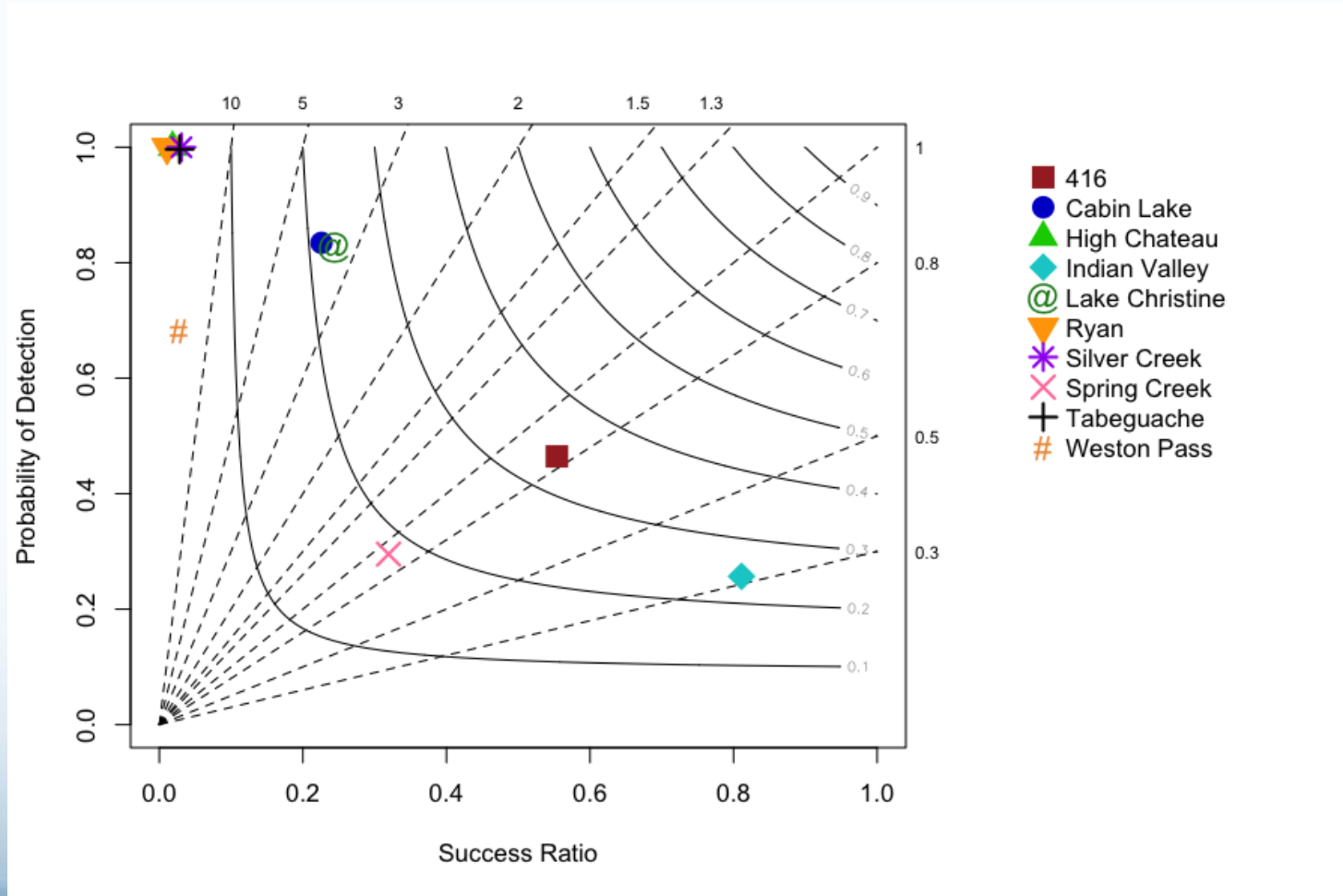
Data are archived and stored in many formats (including file cabinets), or not saved at all



# What Data Do We Have?



# A Fire Blob Is Like A Precipitation Blob



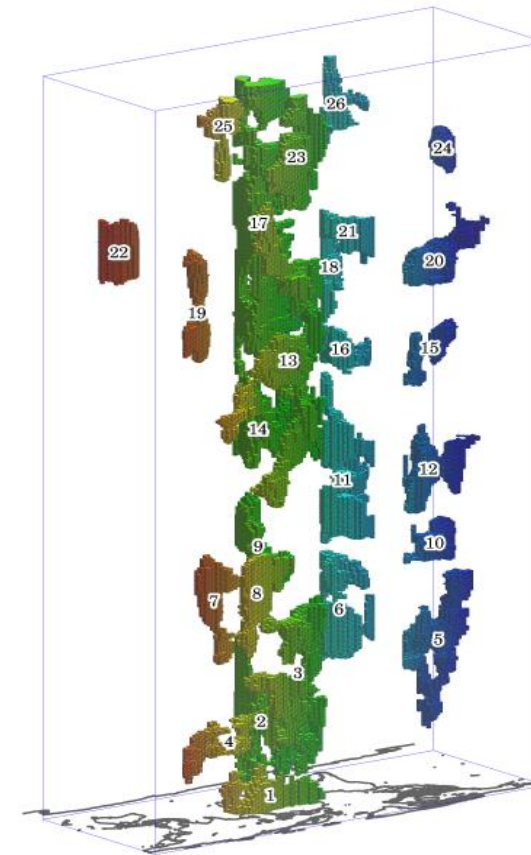
# Verify What Is Important

- Regular stakeholder meetings allow presentation of current state of model and assessment of performance
- Stakeholders may also be able to point you to verification data you are not aware of (e.g., file cabinets or command personnel)
- Feedback on most important uses of CO-FPS
- Example: Overprediction of fire spread is not nearly as important to CO personnel as direction of spread



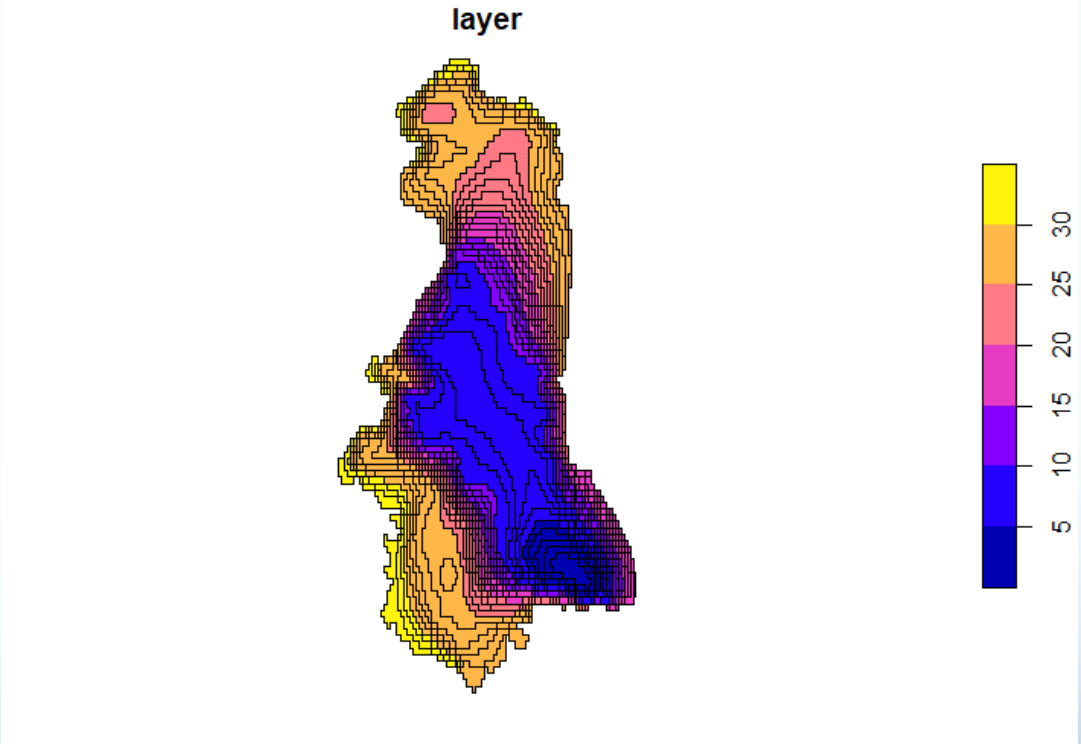
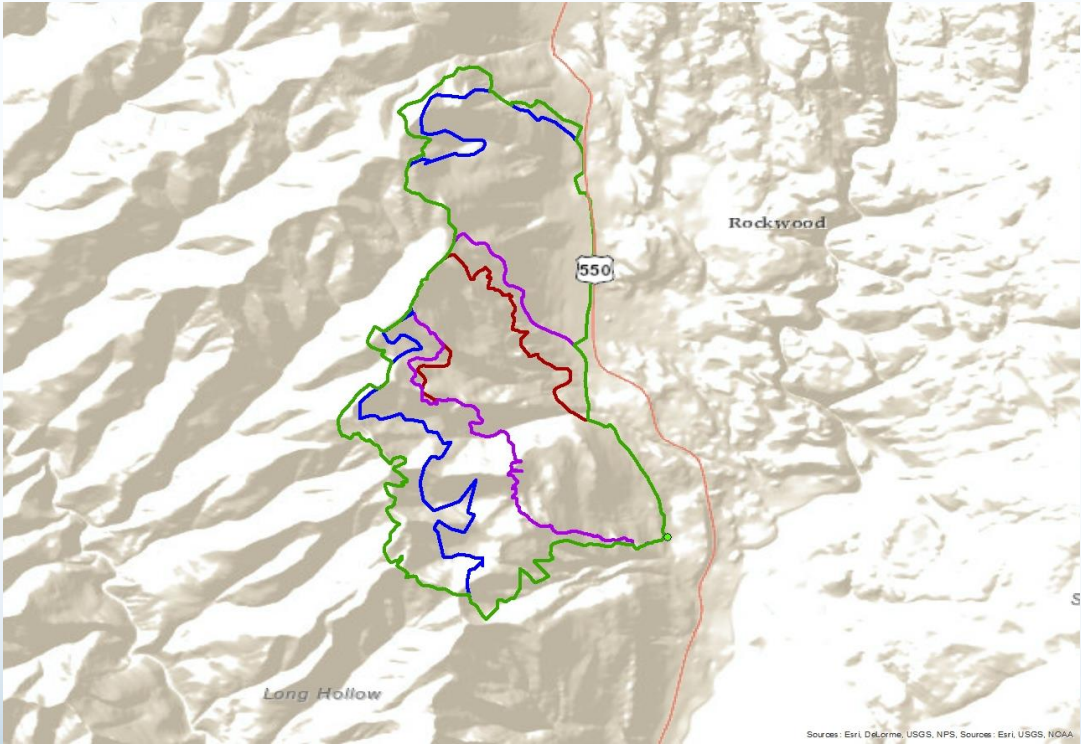
# Adapt Current Verification Tools

- Method for Object-based Diagnostics and Evaluation – Time Domain (MODE-TD) allows for both time and space object-based verification of precipitation or other weather prediction
  - Available as part of Model Evaluation Tools (MET) package at (website)
- Fire spreads in a way similar to precipitation
- MODE-TD's direction and speed metrics could give quantitative assessment of whether CO-FPS captures fire spread

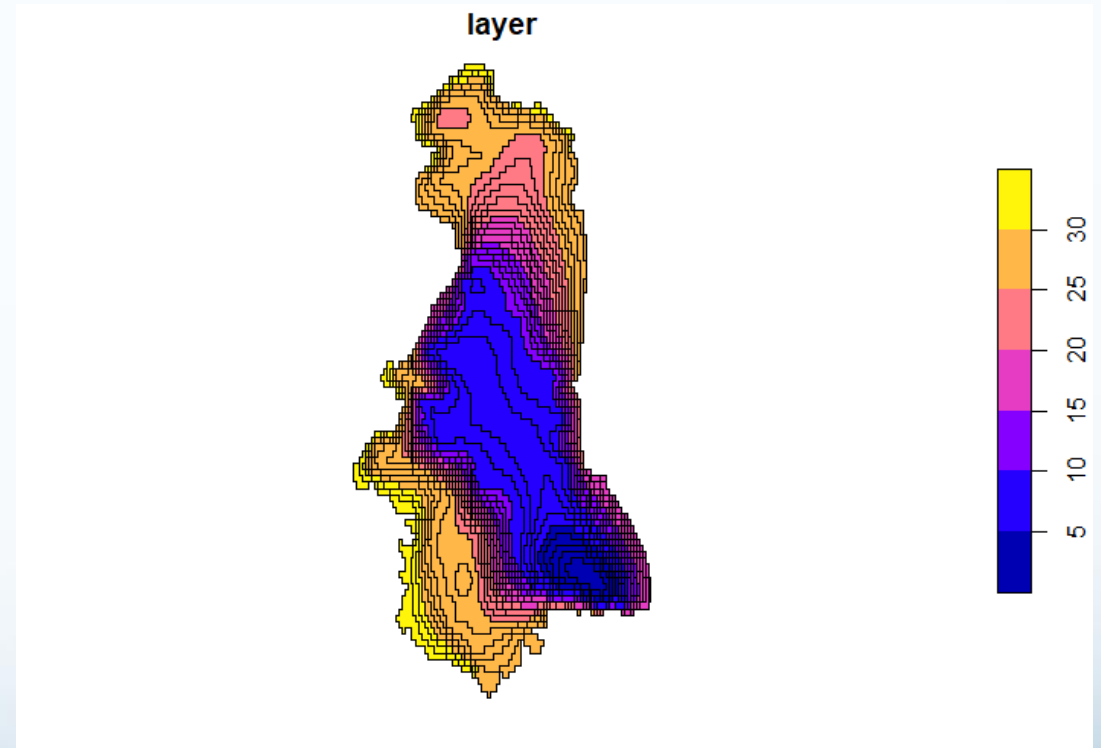
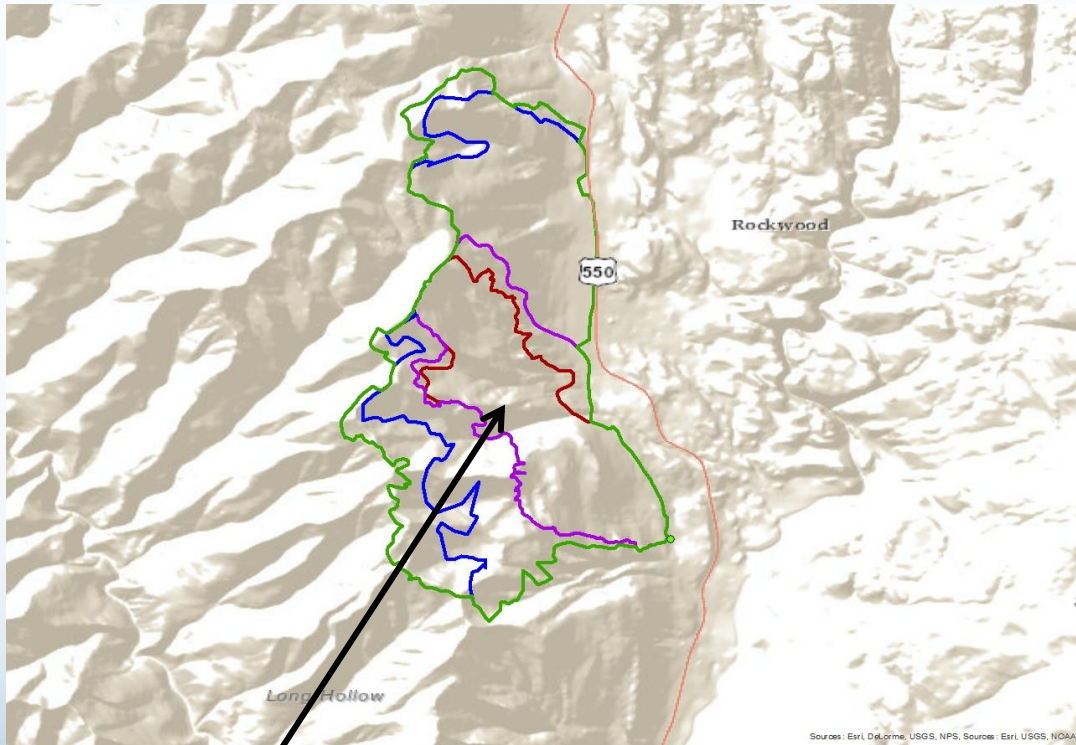


Courtesy Randy Bullock and Barbara Brown

# Requirement – Hourly Observations

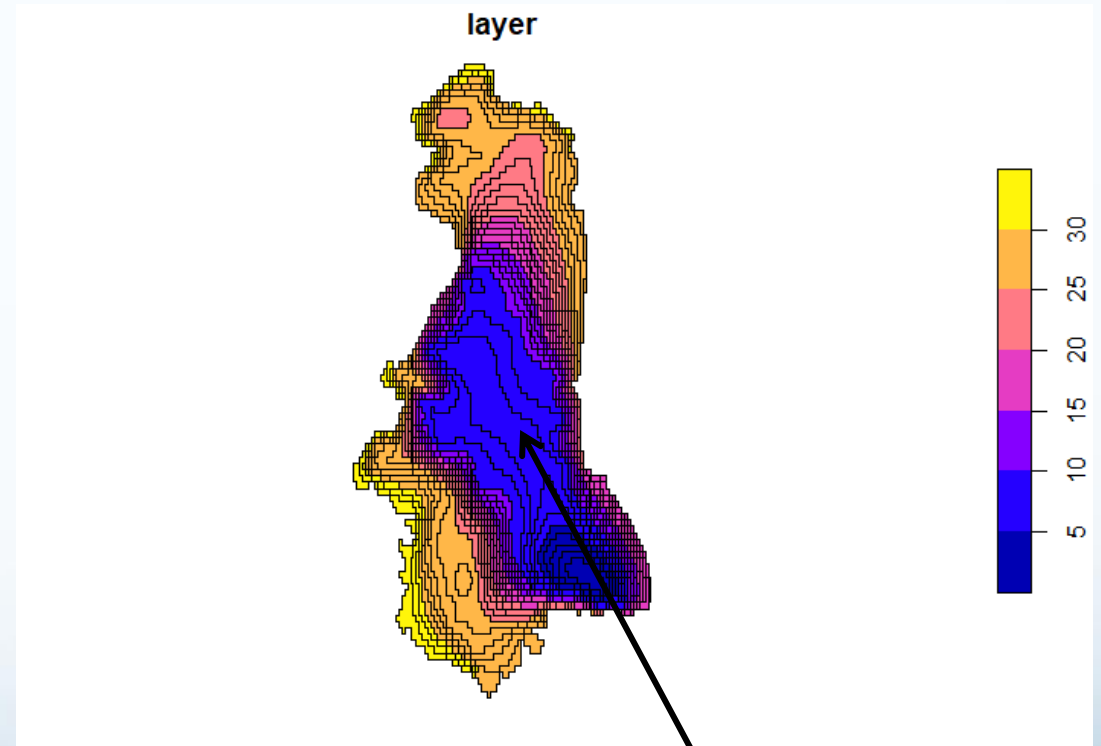
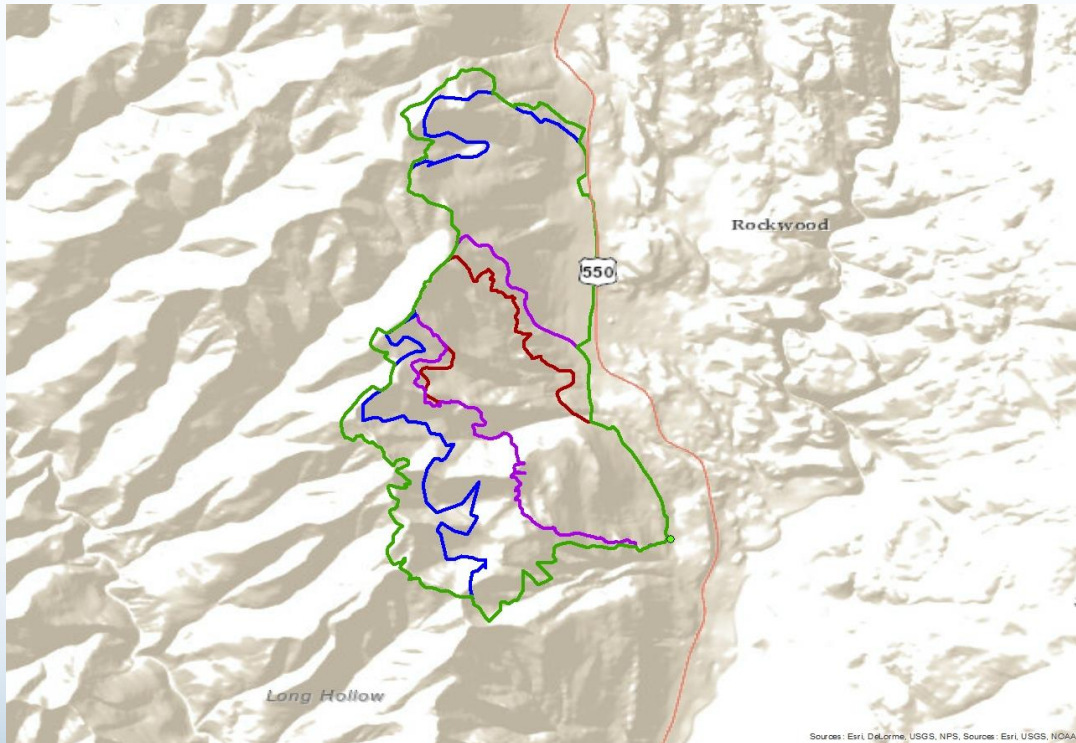


# Requirement – Hourly Observations



416 fire – 4 perimeters  
available across 30 hours

# Requirement – Hourly Observations



Interpolation produces hourly boundaries to allow finer-scale assessment of direction of spread

# Operational Deployment

The screenshot displays a fire simulation software interface. On the left is a control panel with the following elements:

- Back arrow and close (X) button.
- Section header: **Simulations**
- Primary action: **Start New Simulation** (blue button)
- Refresh button
- Timeline controls: play/pause buttons, time **4-30-20 22:00**, and a speed dropdown set to **1 s**.
- Completed Simulations (62) list:
  - CO-WRF-39
  - WYMAN** (highlighted with a blue bar)
  - Fire Boundary
  - Smoke Average
  - Smoke Sum
  - Smoke Max
  - Rate of Spread
  - Heat Release
  - Flame Length
  - Instantaneous Smoke

The main map area shows a topographic map with a fire simulation. A red fire icon is located on the left side of the map. A yellow boundary outlines the fire's spread, and a red boundary indicates a specific fire boundary. The text **380 AC** is visible on the map. Geographic features include **Butler Creek**, **Butler Fork**, **Wynnewood Fork**, and **Sullivan Ditch**. Road markers for **67** and **67A** are also present.

On the right side, there is a legend titled **Simulation Fire Boundary** with a sub-section **FireBoundaries** containing 11 color-coded boxes:

- 1 (Red)
- 2 (Orange)
- 3 (Yellow)
- 4 (Blue)
- 5 (Green)
- 6 (Red)
- 7 (Orange)
- 8 (Yellow)
- 9 (Purple)
- 10 (Green)
- 11 (Red)



# Resources

- Email: [aander@ucar.edu](mailto:aander@ucar.edu)
- CoE: <https://www.cofiretech.org/>
  - <https://www.cofiretech.org/feature-projects/colorado-fire-prediction-system>
- NCAR project page: <https://ral.ucar.edu/projects/colorado-fire-prediction-system-co-fps>